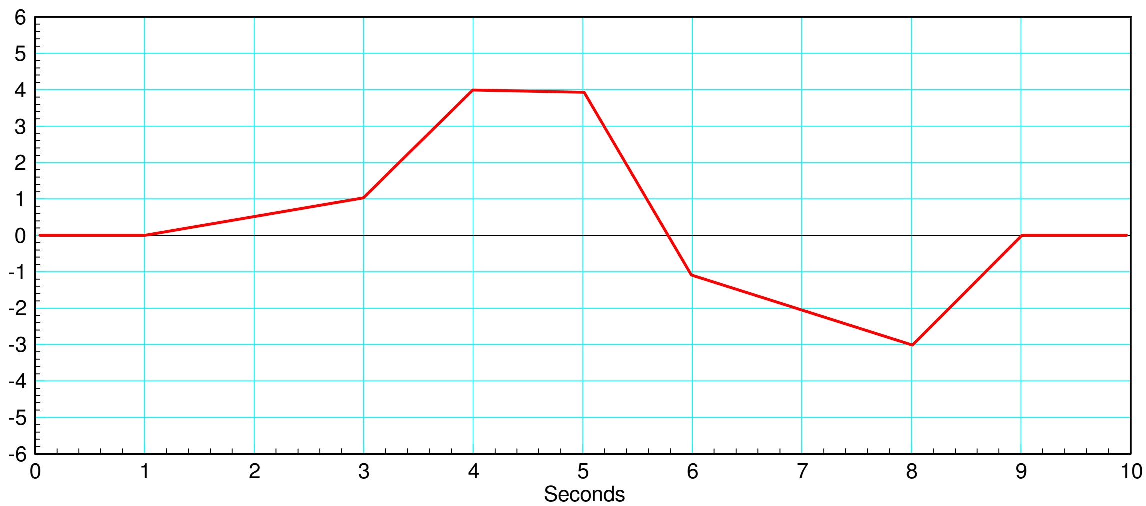
ECE 111 - Homework #10

ECE 311 Circuits II - Heat Equation
Due Monday, March 25th

1) Assume the current flowing through a one Farad capacitor is shown below. Sketch the voltage. Assume V(0) = 0. The voltage is the integral of the current (capacitors are integrators)

$$V = \frac{1}{C}\int I \cdot dt$$

Assume the initial voltage on the capacitor is -5V.



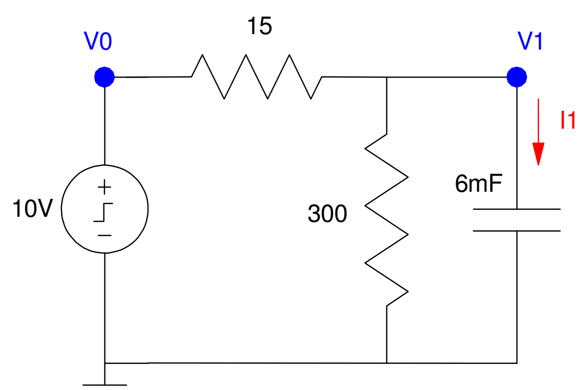
1-Stage RC filter:

2) Write the differential equation that describe this circuit. Note:

$$I_1 = C\frac{dV_1}{dt} = \sum(\text{current to node} V_1)$$

3) Find and plot V1(t) for two seconds using Matlab.

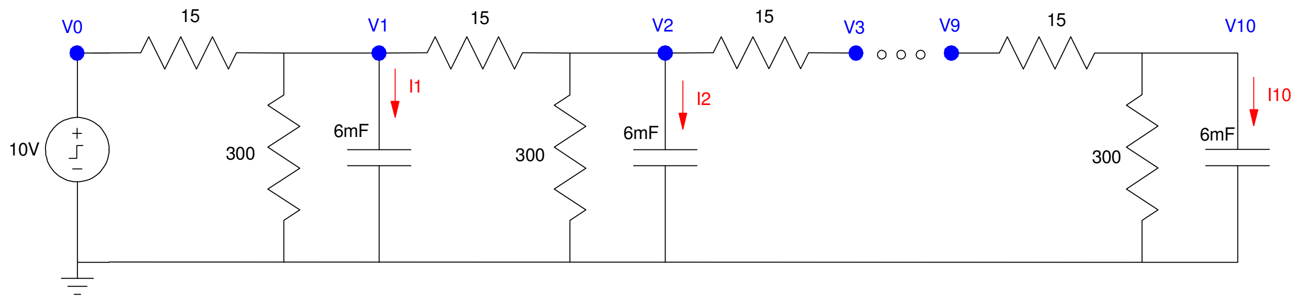
4) Find and plot V1(t) for two seconds using CircuitLab



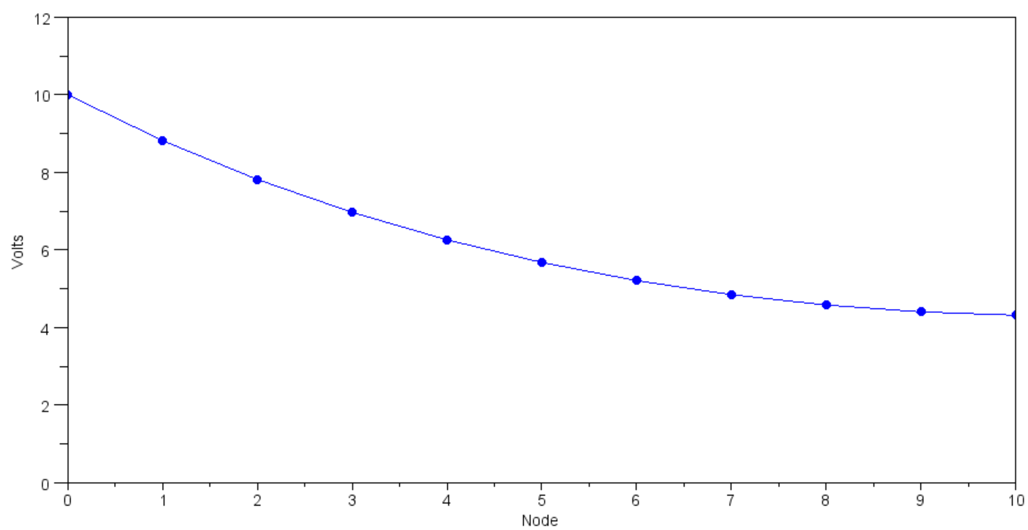
10-Stage RC Filter

5) Write the dynamics for this system as a set of ten coupled differential equations:

$$I_1 = C\frac{dV_1}{dt} = \sum(\text{current to node} V_1)$$



Forced Response for a 10-Node RC Filter (heat.m):



6) Using Matlab, solve these ten differential equations for $0 < t < 5$ s assuming

- The initial voltages are zero, and
- V0 = 10V.

7) Using CircuitLab, find the response of this circuit to a 10V step input. *note: It's OK if you only build this circuit to 3 nodes...*

Natural Response: Eigenvectors and Eigenvalues

8) Assume V0 = 0V. Determine the initial conditions of V1..V10 so that

- The maximum voltage is 10V and
- 5a) The voltages go to zero as slow as possible
- 5b) The voltages go to zero as fast as possible.

Simulate the response for these initial conditions in Matlab.

9) Assume Vin = 0V. Pick random voltages for V1 .. V10 in the range of (0V, 10V):

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V = 10 * rand(10,1)
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Plot the votlages at t = 2. Which eigenvector does it look like?